To investigate the factors which may affect the resistance of resistance putty es...

Planning

There are three different factors, which may affect the resistance of resistance putty. These three factors are temperature, length and thickness. To investigate the temperature it is very hard to make the temperature go up/down in certain intervals, it's also hard to connect the connecting wires to the putty itself. If I were investigating the temperature, the putty would have to be placed in a water bath with a Bunsen Burner underneath. If investigating length, it is easier to connect the connecting wires to the putty whilst making sure only one variable is changed i. e. temperature has to stay the same, thickness the same, but only length changes. If investigating the thickness, the shape and length has to stay the same i. e. rounded shape at the end or square, but only the thickness changes. The thickness could either be measured by measuring the circumference or diameter of the end.

For my investigation, I am going to investigate the length factor to see if the resistance of resistance putty changes. This is because it is the easiest factor to change just one variable, whereas with the others it is slightly harder to change just the one variable.

I predict that for my experiment, the longer the length is, the greater the total resistance will be. I predict this because when doing a previous experiment with changing one variable (length) of a piece of resistance wire in a circuit, the total of resistance increased as the wire got longer. This is because when using a rheostat, the current has to flow through a longer length of coil and we see that the current is smaller, showing the resistance

is larger. Even though wire is not being used in this investigation, I still think that this idea relates to the resistance of resistance putty.

I also predict my graph will look like this:

I don't think I will get results which are directly proportional (This is when one of the quantities is doubled, and the other quantity also doubles. E. g. If Resistance is doubled, length would also be doubled).

I also don't think I will get results which are inversely proportional (This is when one of the quantities is doubled, the other quantity halves. E. g. If length is doubled, the resistance would half). Instead, I think I would get results which are neither of these but have a linear relationship (i. e. both values increase at the same rate.) I also think that even though there is no length of resistance putty in the circuit, there could still be some resistance. This is because connecting wires can carry some resistance in a circuit.

Knowing what resistance is, is very important if an investigation on resistance is being carried out. Therefore, resistance is the ability of a substance to hinder the flow of electricity, a resistor is also related to resistance; it is a device that increases the resistance to an electric current. To calculate resistance, one needs to know the current reading (in Amperes) and the potential difference over the object we are trying to find the resistance of (measured in volts). To work out the resistance from these two values, the formula: –

V = R (i. e. Potential Difference = Resistance)

I Current flowing

The P. d. is always measured in Volts (V), current flowing in amperes (A) and resistance in ohms (?). Along with Ohm's law there is also Kirchoff's current and voltage laws. In Kirchoff's current law, he states that the electric current in amperes, which flows into any junction in an electric circuit, is equal to the current that flows out. This can be seen to be just a statement of conservation of change. Since you do not lose any charge during the flow process around the circuit, the total current in any cross-section of the circuit is the same. This means it doesn't matter where in a circuit you place an ammeter, as the reading will always be the same.

Kirchoff's voltage law states that the voltage changes around any closed loop must sum to zero. No matter what path you take through an electric circuit, if you return it to your starting point you must measure the same voltage, constraining the net change around the loop to be zero. Since voltages is electrical potential energy per unit charge, the voltage law can be seen to be a consequence of conservation of energy.

Resistors can be connected in series or parallel. If connected in series, the total amount of resistance in the circuit is the resistance of the resistors added together (i. e. total resistance = R + R + R …). This is just like varying the length of resistance putty. We can think of the length of resistance putty as being like a number of shorter lengths of putty, joined in series. Therefore, the longer the resistance putty, the greater the total of resistance there will be. We can also think of the electrons as being cars. A long piece of resistance putty can represent a traffic jam on the motorway.

Here, it takes ages to get to where you are going as the queues is so long, and because there are so many cars. Whereas a shorter piece of resistance putty can represent a queue at a roundabout.

At a roundabout, you get to where you want to be quicker, as the queue is shorter than in a long motorway traffic jam. When electrons move through a short piece of resistance putty, they would only feel resistance for a short amount of time compared to a longer piece. This means its resistance is less.

Resistors can also be connected in parallel, here, the total resistance of the circuit is decreased. If two identical resistors are connected in parallel, their combined resistance is half the resistance of either one. To find the combined resistance of resistors in parallel, you use the formula: –

1 = 1 + 1 + 1 ....

R total R R R

For my experiment I need to make it as fair a test as possible. To try to do this, only one variable will be changed (length, not the width nor temperature). Therefore, the width of the resistance putty has to be checked regularly to make sure that it is the same throughout. The temperature also has to stay the same, this can be done by keeping the voltage low so that the putty doesn't heat up. The rest of the circuit which is going to be used also needs to stay the same, this involves being careful when disconnecting the resistance putty from the circuit and replacing the resistance putty back in.

The apparatus which is going to be needed/used, are 3 cells, ammeter, voltmeter, crocodile clips x 2, scalpel, coins x 2, resistance putty, connecting wires, pair of plastic gloves, and a tray lined with plastic. Some of this apparatus is used to keep ourselves/area clean, the others are to be set up in the circuit as shown.

The two coins are pressed into the putty at either end, then the crocodile clips attached to the coins. This is to prevent the error of changing another variable (width) by accident.

The range to be used is going to be from 20cm to 6cm and in intervals of 2cm each time. This results in taking 8 readings all together.

To ensure the experiment is carried out safely, the scalpel (which is used to cut the resistance putty) will only be held when it is needed, otherwise it remains on the bench. The experiment is not going to happen next to a water tap as water and electricity do not mix – it is dangerous, and only a small current is going to be used, as it is much safer than having a larger current.

It is a fair test as only one variable is being changed. This means the temperature, width and the rest of the circuit needs to stay the same, and only the length of resistance putty changing.

Three readings will be taken at each length, these are the ammeter readings (measured to an accuracy of 0. 01A), voltmeter readings (measured to an accuracy of 0. 01V), and a ruler reading (measured to an accuracy of 1mm). There will be 7 readings taken at each length every time the length is

changed. These are the length, ammeter and voltmeter readings, but the ammeter and voltmeter readings will be repeated twice. The first reading at each length will be using 1 cell, the second reading using 2 cells and the third reading at each length will be using 3 cells. With each of these readings, the voltmeter and ammeter readings for a particular length and cell will be divided by one another to get the resistance. For each length, these three resistance calculations will be added and then divided by three to get the average resistance. If the experiment is only down twice, and both results vary a lot, it is very difficult to work out which reading is wrong. Whereas with three readings, it is easier to see which is most likely to be wrong. This is why the experiment is going to be repeated twice.

To test out my method and range, I am going to do a preliminary experiment. For this, I will set up the circuit as I would for the proper experiment, but instead of doing all the different lengths, I will only be using the longest length of resistance putty and the shortest length of resistance putty (i. e. 20 cm and 6cm). Here are my results from my preliminary experiment: –

Length

(cm)

Ammeter Reading (current) (A)

Voltmeter Reading (P. d) (V)

Resistance (?)

(R = V/I)

20

0. 02

1. 54

77. 00

6

0. 03

1. 51

50. 33

From the results above, the resistance between the two values wasn't that great. So, I have decided to amend my range from 20cm to 6 cm, to 16cm to 2 cm. This is because I would like to see whether there is a greater resistance difference between the longest and shortest values, and in what pattern. Even though changing this range might not make a huge amount of difference, I'm still going to see whether it does.

The method I used for my preliminary experiment seems to be good, apart from connecting the resistance putty into the circuit. Even though it is difficult to connect the coins onto the resistance putty whilst trying not to change the width of it, it is still possible to connect the resistance putty into

the circuit. Therefore, there is no need to think of another way to connect the resistance putty into the circuit.

Obtaining Evidence

Whilst doing the experiment I tried to use the equipment as safely as possible by not doing the experiment near a water tap, only using the scalpel when needed etc. Whilst cutting the resistance putty it was difficult to cut it inside the tray lined with plastic, as the ruler I was using was too long to fit in. But, even though this problem occurred, I tried to do the experiment in as safe an environment as possible.

By looking at the table of results, it is possible to see that I managed to get readings for all of the different lengths and with different number of cells. To get these results as accurately as I could, I rolled out the resistance putty to the longest length (20cm) I needed, and took results for this length of resistance putty using one cell, then two cells, and finally three cells. Once I had done this, I cut off 2cm of resistance putty and repeated the same procedure. I did this until I got all of my results, this was the easiest and most systematic way of collecting data for this experiment.

Analysing and Considering Evidence

After repeating the experiment several times, I added the three resistance values and averaged them out to get an overall average resistance for each length. By looking at the averaged resistances, it is possible to see that the resistance increases as the length increases. With these values, a graph was drawn to find what relationship there is between the resistance and the

change in length. This is because it is easier to see this relationship on a graph than in a table of results.

If the graph was a straight line going through the origin, it would show that the results were directly proportional i. e. if the length was doubled, the resistance would also double. If the graph was a curve with the highest point of resistance with the shortest length, and the lowest point of resistance with the highest length, then the results would show that they are inversely proportional i. e. if the length is doubled, the resistance is halved. From looking at my graph, it shows the results are neither inversely or directly proportional. Instead, my graph shows that there is a linear relationship between the two values i. e. length increases at the same rate as resistance, but this is only the case until the length reaches approximately 8cm. From then on, the graph starts to curve. This is because the resistance is increasing at a slower rate than previously but the length is increasing at the same rate.

I can conclude that as the length of resistance putty increases, so does the resistance at the same rate until the resistance putty gets to a certain length and then the increase of resistance slows down.

Looking back at my prediction I stated that ' the longer the length is, the greater the total resistance will be'. This prediction is true but my sketched graph was incorrect, as in my final graph I got a curve at the end. To explain some of the results (where the graph was a straight line) we can think about a rheostat. When using a rheostat, the current has to flow through a longer length of coil and we see that the current is smaller, showing the resistance

is larger. Even though wire was not being used in the experiment, resistance putty conducts electricity and so the same example can apply. This can also explain why a curve occurred, as resistance putty isn't metallic and so what it is made up of can vary a bit from what a wire is made up of. But the resistance is still increasing, just at a different rate.

We can think of the length of resistance putty as being like a number of shorter lengths of putty, joined in series. We know that for resistors in series, the total resistance is equal to the sum of all the individual resistors. Therefore, the longer the resistance putty, the greater the total of resistance there will be. We can also think of the electrons as being cars. A long piece of resistance putty can represent a traffic jam on the motorway.

Here, it takes ages to get to where you are going as the queues is so long, and because there are so many cars. Whereas a shorter piece of resistance putty can represent a queue at a roundabout.

At a roundabout, you get to where you want to be quicker, as the queue is shorter than in a long motorway traffic jam. When electrons move through a short piece of resistance putty, they would only feel resistance for a short amount of time compared to a longer piece. This means its resistance is less.

The longer the resistance putty, the more obstruction the electrons have when trying to travel through it. For example, electrons travelling along a really long piece of resistance putty will encounter more atoms from the putty than a really short one, so the longer the wire, the more resistance.

Evaluating

The method I used was quite easy to use, except some problems did occur. It was very hard to roll out the resistance putty and keep it all the same width, but as the putty got warmer, it did get slightly easier to roll out. It was also very difficult to get a good constant contact between the coins and putty. This could be why the ammeter and voltmeter readings fluctuated quite often.

If the experiment was going to be repeated again, connecting the resistance putty into the circuit could be improved upon. This could be done by putting the resistance putty into a water bath and connecting the wires to the putty in this way. A multi-meter could also be used to stop the two different readings from fluctuating as only one reading will be shown, and this reading can be the resistance which would then save time as calculations would not have to be made.

By looking at my results, they look quite reliable. Even though the resistance readings do vary e. g. for length of 6cm, the resistance readings were 16. 78 ?, 15. 32 ? and 14. 27 ?. But this difference is not too bad as the ammeter and voltmeter readings fluctuated a lot. Also, all of the resistance readings with one cell are different to the other readings of the same length, as the current reading was not accurate enough. I. e. 0. 05A on the ammeter could in fact have been 0. 0596A. Apart from this, my repeated resistance values for the different lengths are approximately in a range of about 1 ? or less. This is very good.

If there had been a bigger difference in the resistance values for a length of 12 cm, then I would have received an anomalous result (i. e. a result is way

out/different from the other two values of the same length). If this had happened, this result would not have been calculated in with the other two resistance values to produce the average resistance. (I. e. only 26. 82 ? and 25. 75 ? would be added together, then divided by two to get the average resistance, as the third value would have been left out completely).

There is also only one point on the graph, which is away from the best-fit line. This could be because I was not being accurate enough with having exactly 8cm of resistance putty and having the width exactly the same as with all the other different lengths. It could also be because for this length, there wasn't such a good connection to the putty from the circuit or the current was not accurate enough. This could be due to the readings constantly fluctuating and the current reading being too small.

Despite having nearly one anomalous result and one point on the graph not on the best-fit line, I think I can say my conclusion is more likely to be valid than invalid. Unless it was just by chance that only one point on my graph didn't fir on the best-fit line.

To make my conclusion more valid, more experiments could be done. If I had more time, I would have investigated these too, so I could get a more valid conclusion.

These experiments would still involve changing just one variable, but instead of having a constant width of 2cm in diameter, the constant width could be 5cm in diameter instead. Or, instead of having a constant temperature of 15ï¿½C, a constant temperature of 20ï¿½C could be used whilst only varying

the length. Even though different resistance values could be calculated, the graph drawn should resemble the same shape as that of the other graphs where only the length is varied for a piece of resistance putty. If this does happen, then it can be safely concluded that my conclusion and results were accurate. But until then it is very difficult to tell whether they are or not.